

***THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI, TAMILNADU***

**A STUDY OF FUNCTIONAL RESULTS OF
MUSCLE TRANSFER FOR RESTORING
ABDUCTION AND EXTERNAL ROTATION IN
OLD OBSTETRIC BRACHIAL PLEXUS PALSY**



***DISSERTATION SUBMITTED FOR
MS DEGREE (BRANCH II - ORTHOPAEDIC SURGERY)
MARCH 2010***

DEPARTMENT OF ORTHOPAEDICS
MADURAI MEDICAL COLLEGE AND
GOVERNMENT RAJAJI HOSPITAL
MADURAI.

CERTIFICATE

This is to certify that the dissertation entitled **“A STUDY OF FUNCTIONAL RESULTS OF MUSCLE TRANSFER FOR RESTORING ABDUCTION AND EXTERNAL ROTATION IN OLD OBSTETRIC BRACHIAL PLEXUS PALSY”** is a bonafide record of work done by *Dr. R.J.BHARAT KUMAR* in the Department of Orthopaedics and Traumatology, Government Rajaji Hospital, Madurai Medical College, Madurai, under the direct guidance of me.

Prof. V. RAVIRAMAN, M.S.ORTHO., D. ORTHO.,
Professor and Head of the Department
Department of Orthopaedics
Madurai Medical College and
Government Rajaji Hospital,
Madurai.

DECLARATION

I **Dr. R.J.BHARAT KUMAR**, solemnly declare that the dissertation entitled “**A STUDY OF FUNCTIONAL RESULTS OF MUSCLE TRANSFER FOR RESTORING ABDUCTION AND EXTERNAL ROTATION IN OLD OBSTETRIC BRACHIAL PLEXUS PALSY**” has been prepared by me under the able guidance and supervision of my guide **Prof. V. Raviraman, M.S.Ortho., D.Ortho., Prof & HOD**, Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai, in partial fulfillment of the regulation for the award of **M.S. (ORTHOPAEDIC SURGERY)** degree examination of The Tamilnadu Dr. M.G.R. Medical University, Chennai to be held in March 2010.

This work has not formed the basis for the award of any other degree or diploma to me previously from any other university.

Place : Madurai

Date :

Dr.R.J.BHARAT KUMAR

ACKNOWLEDGEMENT

I am deeply indebted to my beloved chief and my teacher, **Prof. V.Raviraman, M.S.Ortho, D.Ortho., Professor and Head of the Department of Orthopaedics, Madurai Medical College, Madurai** for the able guidance, inspiration and encouragement he has rendered at every stage of this study.

I am grateful to my beloved teachers **Prof. M.Chidambaram, Prof.Malairaju, Prof.A.Rajamani, Prof.S.Shanmuganathan, Prof.P.V. Pughalenth, Prof.R.Sivakumar** for their invaluable help and guidance rendered to me in preparing this dissertation.

I express my heartfelt gratitude to my beloved teacher **Prof. T.Chandraprakasm M.S., Ortho.** for his able guidance, inspiration and encouragement he has rendered at every stage of this study.

I sincerely acknowledge with gratitude the guidance and persistent encouragement given to me by all out assistant professors in the department of orthopaedics.

My sincere thanks to **The Dean, Madurai Medical College, Madurai** for permitting me to utilize the clinical materials of the hospital.

I would like to thank my patients, friends and colleagues & family who have stood by me throughout this work and above all the **GOD FOR HIS KINDNESS THROUGHOUT THIS STUDY.**

CONTENTS

S. NO	CONTENTS	PAGE NO
1	INTRODUCTION	1
2	SURGICAL ANATOMY OF BRACHIAL PLEXUS	4
3	RISK FACTORS	10
4	MECHANISM OF INJURY	13
5	THE NATURAL HISTORY	15
6	PATHOLOGY	18
7	SEQUELAE	19
8	CLASSIFICATION	21
9	NEUROPHYSIOLOGICAL STUDIES	23
10	LATE OBSTETRIC BRACHIAL PLEXUS PALSY	27
11	GLENOHUMERAL DEFORMITIES IN OBSTETRIC PALSY	36
12	AIM	43
13	MATERIALS AND METHODS	44
14	RESULTS AND ANALYSIS	61
15	DISCUSSION	66
16	CONCLUSION	71
	ANNEXURES	
	BIBLIOGRAPHY	
	PROFORMA	
	MASTER CHART	

INTRODUCTION AND HISTORY

For centuries obstetric brachial plexus palsy was confused with other congenital conditions.

Smellie in 1795 is credited with the first description of a child with bilateral weakness of both upperlimbs who rapidly recovered.

Danyou in 1851 described autopsy findings in a 8 day old baby in whom the upper trunk was infiltrated with blood but not ruptured .

Duchenne described patients who presented with an unusual injury, of avulsion of C5 and C6.

Klumpke described lesions of lower nerves of the brachial plexus.

Trombetta in 1880 identified two groups of babies particularly at risk - the heavy baby and baby born by breech.

Duval and Guillian in 1898, showed that the brachial plexus was stretched and C5 and C6 were prone to rupture when shoulder was forcibly depressed.

Boyer found a lesion in the spinal cord at autopsy in a 41 year old woman.

In the beginning of the century there was much interest in operative repair. Kennedy in 1903 described three early repairs of upper trunk in

obstetric palsy. Clark in 1905 described seven early nerve repair and in 1920 Taylor operated on 80 cases of obstetric palsy out of 200 cases.

Wyeth and Sharpe after reviewing 81 cases, recommended operation at the age of 1 month in complete lesions and at 3 months for incomplete lesions with no spontaneous improvement.

The next two generations saw much interest in palliative operations. In the late 1970s Morelli in northern Italy and Narakas in Lausanne encouraged by their experience in adults made a disciplined start in redefining indications for and techniques of operative repair. Gilbert and Tassin described the natural history in an untreated obstetric brachial plexus palsy population.

Zancolli and Zancolli continued with extensive analysis of the associated secondary deformities.

INCIDENCE:

The incidence of these injuries is suggested to be 4/1000 where medical facilities are poor and quoted as 0.1 – 0.3/1000 with good obstetrical care.

In 1% of obstetric brachial plexus the injury is bilateral, more on one side (exclusive in breech).

This gives an idea of the gravity of the situation and why effective and timely methods of management are necessary.

One of the famous examples of obstetric brachial plexus palsy was that of Kaiser Wilhelm II, grandson of Queen Victoria whose breech presentation was complicated by nuchal arms and whose left arm was used to turn the body.



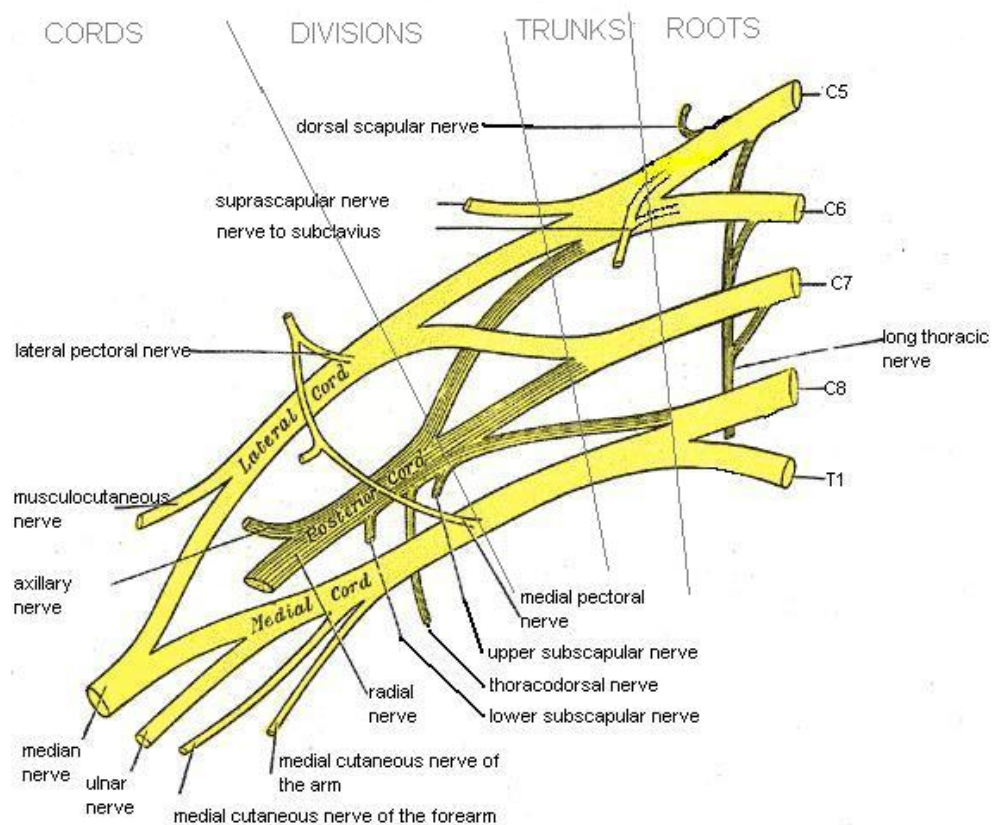
SURGICAL ANATOMY OF BRACHIAL PLEXUS:

The Brachial plexus is formed by the union of the anterior rami of C5, C6, C7, C8 and T1. The C5 usually receives some fibers from C4 and T1 from T2. The formation of the Brachial plexus begins just distal to the scalene muscles. Here the C5 and C6 roots unite to form the upper trunk, the C7 root continues alone to form the middle trunk and the C8 and T1 unite to form the lower trunk. The three trunks thus formed, proceed inferolaterally behind the Clavicle, and each divides into anterior and posterior divisions. The three posterior divisions unite to form the posterior cord, the anterior divisions of the upper and middle trunks unite to form the lateral cord, and the anterior division of the lower trunk continues alone to form the medial cord. These three cords embrace the Axillary artery in the relationships that their names imply.

The surgically important nerves arising from the level of the roots are Long Thoracic nerve (C5, C6, C7), Dorsal Scapular nerve (C5) and Nerve to Serratus Anterior. The only nerve to arise from the trunk is the Suprascapular nerve.

The Lateral Pectoral nerve arises from the lateral cord and the medial pectoral nerve from the medial cord. The Musculocutaneous nerve

is the only additional branch of the lateral cord. The remainder of the cord joins the medial cord to form the Median nerve. The Medial Brachial cutaneous and Medial Antebrachial cutaneous nerves arise from the medial cord which then divides into its two main branches - one the Ulnar nerve and the other its contribution to the Median nerve. The upper and lower Subscapular nerves arise from the posterior cord. The Thoraco Dorsal nerve and the Axillary nerve arise from the posterior cord after which the cord continues distally as the Radial Nerve.



The length of the nerve roots range from 10 mm to 168 mm , the shortest being the cervical roots and the longest the sacral. Short nerve roots suffer injuries earlier and fail structurally before the long roots. So the short cervical spinal nerve roots of brachial plexus are particularly vulnerable to traction deformation.

At the level of perforation of the dura mater, the roots gather and organize into bundles varying in number between 2 and 6 according to the level. At the origin of the spinal nerves, the motor and sensory fibres are mixed as a result of the convergence of the ventral and dorsal roots. After the mixing of the ventral and dorsal roots, it is impossible to determine the topography of the motor and sensory fibres on the histological section.

The number of fascicles increases from proximal to distal portion of the plexus. The diameter of the fascicles progress inversely, with large fascicles in the proximal part and small fascicles in the distal part.

Although the denticulate ligament stabilizes the spinal cord and reduces mechanical trauma to the ventral and dorsal roots, the major point of fixation is situated in the intervertebral foramen, where the duramater adheres to the periosteum and contributes to the formation of the

perineurium. The lateral portion of the transverse process is the final anchorage.

A few millimeters from its emergence at the intervertebral foramen, a dorsal ramus that innervates the paraspinal muscles is divided from the spinal nerve.

There is a characteristic change in the direction of spinal nerves where the intermediate portion tends to become horizontal in the canal and then turns downwards to the extravertebral portion. There are two slopes one at the penetrating site of the duramater and the other external to the intertransverse canal. This Z arrangement is vulnerable to trauma.

The spinal nerves have an oblique angle to a vertical axis in the frontal plane that decreases from 138° for C5, 123° for C6, 114° for C7 to 85° for T1.

The upper roots are different from the lower roots by their relationship as well as by their means of fixation.

The upper roots are connected to the cervical spine by transversoradicular ligaments. This explains why avulsion are more frequent in lower roots compared to the upper roots.

ANOMALIES OF THE PLEXUS:

The posterior cord is discrete in 25% but in 71% it diverge into its corresponding nerve roots. In 4% a posterior division continues on directly as the radial nerve.

C8 contributes occasionally to the lateral cord.

Anastomosis between musculocutaneous and median nerves were observed in 24% of the cases.

SYMPATHETIC CONTRIBUTION TO THE ROOTS:

The relative percentage of contribution of the sympathetic fibres to each individual roots of the plexus is variable. The C5 and C6 nerves receive single or multiple gray rami from the middle cervical ganglion or the superior cervical ganglion. C8 and T1 receive sympathetic post ganglionic fibres from the stellate ganglion. C5 and C6 have fewer post ganglionic fibres compared to C8 and T1.

VASCULAR SUPPLY OF THE PLEXUS:

Three main branches supply the brachial plexus

- deep cervical arteries that arises from the subclavian artery for C5 to T1 cervical spinal nerves .
- scapular posterior artery for the upper and middle trunks.

- branches directly from the subclavian artery.
- branches from transverse cervical artery or axillary artery for medial and lateral cords.

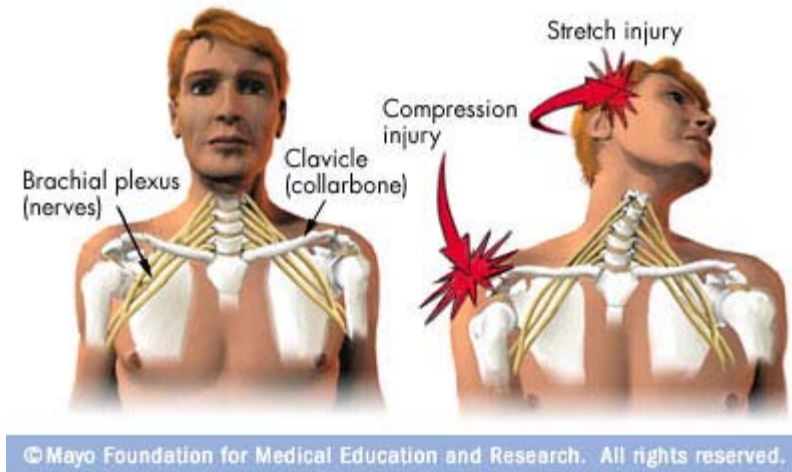
Dohno et al evaluated the microvascular architecture of the brachial plexus. He observed extravascular capillary networks are few and there is a hypovascular area in the brachial plexus below the clavicle.

Brachial plexus as such has a greater tendency to be susceptible to ischemia with stretching and compression injuries compared to the peripheral nerves as they do not have the segmental epineural vessels with well defined endoneural and perineural microvascular system as seen in the peripheral nerves.

COMMON MECHANISMS OF INJURY:

- downward pull of the shoulder away from the cervical spine commonly occurs in motor vehicle accidents. The severity of the lesion depends on the position of the arm and the degree of abduction at the time of injury with maximum stress occurring at 90 abduction.
- stretching of the upper limb in maximum abduction causing paralysis C8 and T1.

- Anteroposterior trauma and dislocation of the shoulder causing lesions of the cord and terminal branches of the plexus.



RISK FACTORS:

Two risk factors are important

- breech delivery
- weight of the baby
- shoulder dystocia

Breech delivery is associated with severe injuries often bilateral in which the upper spinal nerves of the plexus are frequently avulsed from the spinal cord. These were small babies often premature.

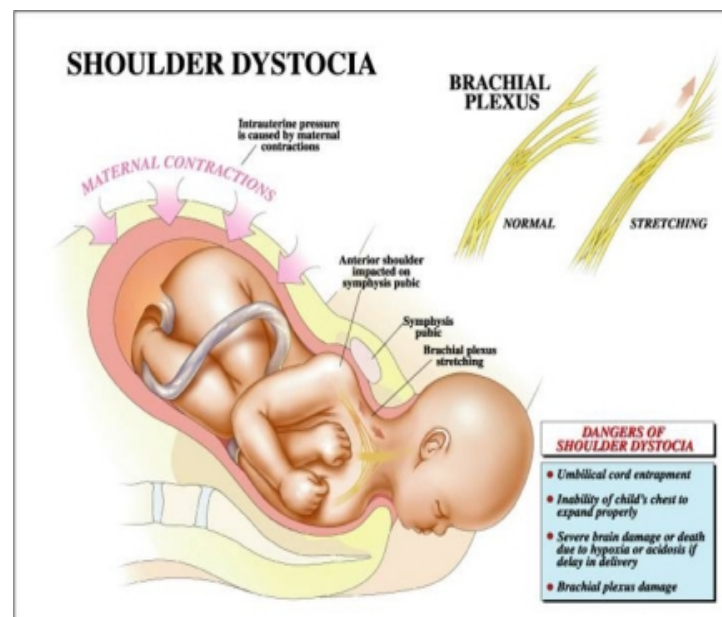
Slooff and Blaauw described 40 cases of obstetric brachial plexus palsy delivered by breech. In 11 the lesions are bilateral, in 12 there is phrenic nerve palsy, and in 2 there is complete lesion.

The heavy baby born by cephalic presentation is at risk.

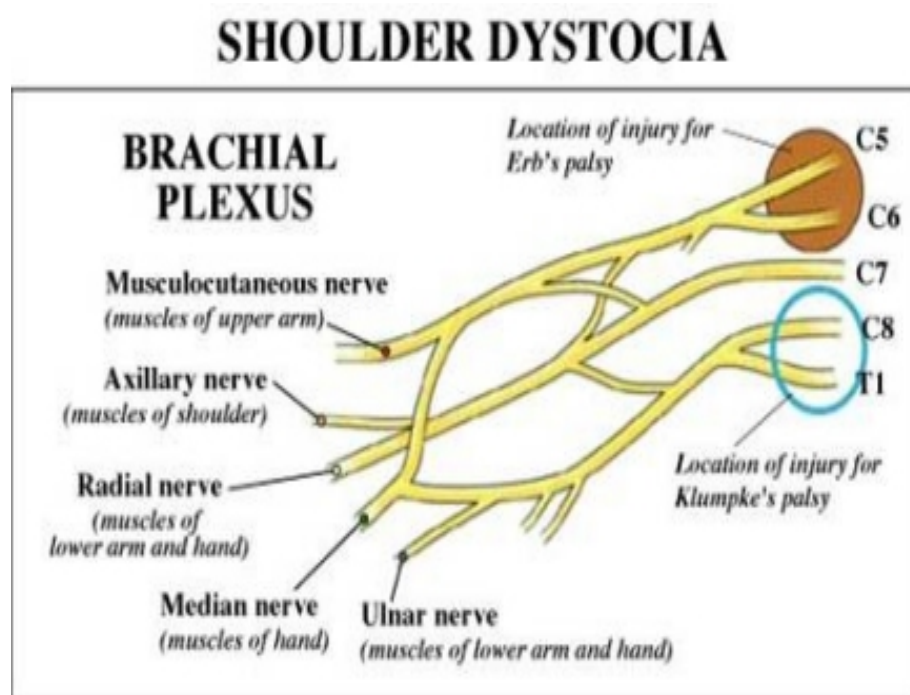
Zancolli and zancolli found that 90% of their 512 cases weighed more than 4 kg at birth.

Four main groups of risk factors were analysed by various authors, those affecting the parents, those occurring during pregnancy, those occurring during labour and those relating to the child.

The mother of these children tend to be heavier, shorter and there was also excessive weight gain during pregnancy. However they were not of statistical significance.



The one factor of obvious and statistical significance was the birth weight of the baby with a mean of 4.5 kg. The severity of the lesion increased with the birth weight and shoulder dystocia being recorded as a complication of birth in over 60% of the cases.



SHOULDER DYSTOCIA:

It is defined to describe a wide range of difficulties encountered in the delivery of the shoulders.

It is realized that the problem lies in the pelvic inlet, commonly the posterior shoulder in the sacral bay but the anterior shoulder remains above the symphysis pubis. Rarely, both shoulders remain above the pelvic inlet.

PREDISPOSING FACTORS:

- Fetal macrosomia
- Maternal obesity
- Maternal diabetes
- Post maturity
- Multiparity
- Mid pelvic instrumental delivery, particularly with vacuum than forceps.

MECHANISM OF INJURY:

Stretching is the main cause of these lesions.

Many overweight babies (>4kg) in cephalic presentations and underweight babies in breech presentations may develop obstetric brachial plexus palsy, apparently caused by forceful widening of the angle between the neck and shoulder, particularly when fetal distress (hypoxia) causes a loss of normal muscle tone.

This distraction of the brachial plexus with the shoulder held down and head curved to opposite side is widely accepted to be the most probable cause of obstetric brachial plexus palsy. This force acts with

diminishing violence from C5 downwards to T1 and is not a high energy injury.

A vertex delivery focuses stretch at the upper plexus whereas in a breech it is at the lower plexus.

The anatomical variation of the prefixed plexus, where there is a greater contribution from C4 root, may predispose the infant not to tolerate even less stress across the plexus.

The lesion is always supraclavicular and is not associated with a vascular injury.

THE TRACTOR TRAILER THEORY:

Sandmire studied patients with extremely rapid second stages of labor, some of which are as short as one or two contractions. He noted that the forces of contraction and maternal pushing act on the long axis of the fetus. If the fetus's anterior shoulder were to get stuck behind the maternal pubic bone and continued pressure was applied along the long axis of fetus, the baby's brachial plexus would undergo stretching.

Most brachial plexus injuries occur to baby's right arm (60%).

This is because babies most commonly "present" into the mother's pelvis in the left occiput anterior position (LOA). The LOA position is

where the back of the baby's head – the occiput – points towards the mother's left arm while the fetal face is oriented towards the mother's right buttock. In this fetal position the baby's right arm will be anterior and thus more likely to get caught under the mother's pubic bone.

But brachial plexus injuries have also been reported in the posterior shoulder.

In these cases, the posterior shoulder gets caught on and restrained by the sacral promontory while the remainder of the baby is being pushed forward by the mother's expulsive efforts or by her uterine contractions. The posterior brachial plexus would thus be stretched, potentially injuring it.

THE NATURAL HISTORY:

There were many works on the natural evolution of the condition, A J Harrold reported a favourable outcome in 80% of the cases. On the otherhand Sharrad found recovery was poor in atleast half of the babies born with complete lesions. G Jorup followed 103 patients for over 33 years, finding 22 with poor results, 40 had useful recovery but with persistent and significant disability.

Narakas analysed outcome in 460 patients and found that few babies born with complete paralysis made good recovery at the shoulder and 90% developed good hand function.

Zancolli and zancolli followed 512 cases in 184 children. They found 82% of those with damage to the C5 and C6 regained elbow flexion at or soon after 5 months. When the seventh cervical nerve was damaged more than half did not regain elbow extension. Those with damage to the C8 and T1 nerves, one – fifth made no recovery of the hand. They found that if hand function was evident at 3 months, the outcome was good but if there was no recovery at all by 6 months then hand function would be poor or absent.

A prospective study from Gilbert and Tassin in 44 infants in paris, 14 (32%) made complete recovery and these showed early and rapid improvement in deltoid and biceps by no later than 2 months. 11(25%) showed useful recovery but not of active lateral rotation. 19(43%) made far from full recovery with biceps starting at between 6 – 10 months from birth.

Gilbert and Tassin with Narakas proposed a classification of obstetric brachial plexus palsy replacing earlier eponymous systems.

GROUP	NERVES	PRESENTATION	PROGNOSIS
Group 1	C5-6	Paralysis of shoulder; Absent Elbow flexion	Spontaneous recovery in over 80%
Group 2	C5-6-7	As above with wrist drop	Good hand. Good shoulder and Elbow in 60%
Group 3	All	Complete paralysis	Good hand in majority Good shoulder and elbow in 30- 50%
Group 4	All	Complete paralysis. Bernard- Horner sign. Limb may be atonic, Marbled and cold	Full recovery is rare. Severe defect throughout the limb likely

The disparity in limb length ranges from upto 2% in group I to 20% in group 4. Damage to the cord in 2% of the group 4 babies, appears as delayed and unsteady walking. There is measurable discrepancy in the size of the foot.

The classification can be applied from 2 – 4 weeks from birth when simple conduction block lesions should have recovered. It clearly defines the extent of injury to the brachial plexus and offers a broad guide to prognosis. But it doesnot recognize the klumpke’s lesion of C8 T1.

Progress of recovery or the lack of it in the first 8 weeks is critical. In favourable lesions, there is a powerful grasp at 2 – 4 weeks, flexion of shoulder and elbow at 6 – 8 weeks. Early return of grasp virtually guarantees that the child will regain good hand function. Persisting paralysis of deltoid and biceps at 3 months confirms a deep lesion of C5 and C6 nerves.

Some children in group 3 and 4 show recovery of shoulder and arm between 3 – 6 months but never regain hand function and present with supination deformity of the forearm, atrophy of digits and limited flexion of fingers.

Children with obstetric brachial plexus palsy remarkably have so little evidence of anaesthesia and that sympathetic function usually returns. Self mutilation is distinctly uncommon.

PATHOLOGY:

Lesions range from degree I (neuropraxia) to degree V (neurotmesis or root avulsion). The upper trunk is the first to be damaged. Then sequentially, the middle and lower trunk are involved

C5 C6 – badly stretched and infrequently ruptured

C7 root – stretched, ruptured or avulsed

C8 T1 – mostly avulsed from the cord, but rare.

As described by Kondo,

Obstetric brachial plexus palsy has some regularity as follows:

- the most vulnerable part of plexus is the upper trunk
- if the injury reaches the lower plexus , the injury of the upper plexus becomes more severe.
- Klumpke's type of palsy sparing the upper trunk is rare. This occurs possibly in caesarean section where pull is applied on a hyper abducted extremity.
- Recovery of ECR is an index of severity of injury.
- poor recovery of ECR means injury has exceeded the level of C7.

SEQUELAE:

In obstetric brachial plexus palsy, nerves are either stretched or ruptured. The nerve gaps are short which makes nerve regeneration possible resulting in sequelae:

- Some muscles recover earlier whereas others remain paretic leading to muscle imbalance.
- Motor recovery results from misdirection of regenerated axons
Cross innervation .

Kondo emphasized the importance of cross innervation in obstetric palsy in 1991. Cross innervation causes cocontractions of the synergistic and the antagonistic muscle groups resulting in diminished functional recovery and muscle contractures causing shoulder and elbow deformity in late obstetric brachial plexus palsy .

DIFFERENCE BETWEEN OBSTETRIC BRACHIAL PLEXUS PALSY (OBPP) AND TRAUMATIC BRACHIAL PLEXUS PALSY(TBPP):

OBPP	TBPP
Always low energy traction force	Higher velocity or penetrating injury
Most often supraclavicular lesion	Complete rupture or avulsion
Intervening gaps short	Intervening gaps are long
Scars are scanty	Scarring is dense
Regeneration is possible	Regeneration is impossible
Cross innervation is possible	Cross innervation is not possible
Flaccid paralysis	Partial paresis with deformity

The only similarity being – traction, the mechanism.

CLASSIFICATION:

Obstetric brachial plexus palsy (OBPP) is now divided into two categories

- early OBPP (OBPP in infant)
- late OBPP with deformity (OBPP in child)

Age in late OBPP is defined as age when the patient responds well to order. Usually after the age of 3 or more because it is easy to evaluate.

CLINICAL ASSESSMENT AND DIAGNOSIS:

The diagnosis is usually evident. The upper extremity is flail and dangling. Opposite extremity and lower limbs examined to rule out neonatal tetraplegia which has poor prognosis.

Muscle testing allows determination of two basic clinical types

- Paralysis of upper trunk is evident. The arm is held in internal rotation and pronation. Active abduction is impossible.
- The elbow may be flexed slightly (paralysis C5, 6, 7) or in complete extension (paralysis of C5, C6). The thumb is in flexion and sometimes even the fingers will not extend. As a rule, flexion of thumb and fingers are functioning. Pectoralis major is often

active giving an appearance of forward flexion. No vasomotor sign and no impairment of sensation.

- There may be complete paralysis. The entire arm is flail and pinching produces no reaction. There is vasomotor impairment and the flail extremity is rather pale or marble – like. Bernard horners sign may be positive.

Further natural course of the condition is variable. Sometimes within a few days, complete recovery occurs.

- The extent of paralysis regresses and becomes limited to upper roots.
- No improvement may be seen in complete paralysis.

Small children are assessed by the following scale:

MO	Complete palsy , no contraction
M1	Contraction with out movement (shoulder, elbow, wrist), slight movement of digit
M2	Incomplete movement or weak complete movement when suppressing gravity
M3	Complete movement with apparently normal force

S0	No reaction to painful or other stimuli
S1	Reaction to painful stimuli , not to touch
S2	Reaction to touch , not to light touch
S3	Normal sensation

INVESTIGATIONS :

ROENTGENOGRAMS:

- to identify epiphyseal fractures of the humerus and fractures of the clavicle .
- comparable plain Xrays of both shoulders may show an increase in the distance between the acromion and the humeral metaphysis.
- in late stages it shows, retraction of growth and deformity of the shoulder joint.

NEUROPHYSIOLOGICAL STUDIES:

When done in 3 – 4 weeks neuro physiological shoulder will confirm neuropraxia or axonotmesis. At 2 months these studies show possible signs of reinnervation.

In later stages, EMG may be confusing as it does not reflect function. Clinical judgement prevails.

Evoked sensory potentials are useful to ascertain root avulsion and can be used preoperatively to test the validity of the proximal stumps.

The place for neurophysiological investigation remain controversial. Some clinicians with great experience consider electromyography unreliable, offering unduly favourable evidence. It is only fair to say that the neurophysiological investigation must be done expertly and interpreted expertly. Smith(1996) has acquired great experience from analysis of over 500 infants, assessing babies with a combination of mixed nerve action potentials and EMG examinations of selected muscles. Smith summed up the role of electrodiagnosis as follows “*firstly, to determine the extent and the level of the involvement of the individual components of the plexus; secondly to identify the root avulsion and thirdly to define the nature of lesions in terms of neuropraxia, axonotemic, and neurotomic injury, thus to assist in making a prognosis*”. Kono (1999) matched these preoperative projections with the findings at operation in 150 cases and showed a high degree of accuracy. One hundred and thirty eight roots from 145 classed as type C were found, at operation, to be either ruptured or avulsed or to have combinations of both. Premature electrodiagnostic investigation will

show evidence of complete degenerative lesions, implying that the outlook is less favorable than in fact it is, and these tests seem to be most reliable at about 12 weeks of age.

Intraoperative neurophysiological investigation is as necessary as any pre-operative work. Sensory evoked potentials are recorded from each spinal nerve. The distal muscular response is noted. In post-ganglionic injury there is always some distal muscular response and nerve action potentials can be recorded across the lesion in many of the cases.

TYPE	NAP	EMG	LESION
Type I	Normal	No spontaneous activity. Reduced number of normal motor units, increasing firing rates	Conduction block
Type II	Normal, or >50% of uninjured side	Relatively good motor unit recruitment. Mixture of normal units and potential suggesting collateral reinnervation	Mild axonal lesion (Axonotmesis).
Type III	Absent or <50% of uninjured side	Normal units few or absent. Collateral re-innervation.	Significant axonal lesion (Neurotmesis).
Type IV	Absent, occasionally present	Spontaneous activity. Nascent units. Poor recruitment.	Severe axonal injury (Neurotmesis or intradural)

OTHER MODALITIES OF INVESTIGATION:

Fluoroscopy shows a associated phrenic nerve palsy. Lumbar puncture shows xanthochromic CSF confirming root avulsion.

Myelogram only if surgery is contemplated.

Contrast enhanced CT scan combined with myelogram and MRI is used.

Recently a special sequence of MRI entitled fast spin ECHO unlike CT myelography provides high speed noninvasive imaging that allows clinicians to evaluate preganglionic nerve root injuries.

OPTIONS IN EARLY OBSTETRIC BRACHIAL PLEXUS PALSY:

CONSERVATIVE MANAGEMENT:

The extremity is either left along the side of the newborn, when supine or put across the chest, with elbow flexed in a sleeve.

Additional trauma is prevented by avoiding abduction and posterior projection of the shoulder and limb must be supported when holding the baby.

While all joints are frequently mobilized, shoulder is put at rest for 3 weeks. From then on, progressive mobilization of the joint in external rotation and abduction until a full range of motion is obtained.

SURGICAL MANAGEMENT:

INDICATIONS:

Failure of recovery of the biceps by 3 months.

Group 3 and group 4 lesions

Presence of horners sign

TIMING OF SURGERY:

Total palsy – 3 months

Upper trunk palsy – 5 months

ADVANTAGES OF EARLY NERVE REPAIR:

- diminishing potential for axon regeneration with age and late surgery.
- cross innervation and muscle imbalance aborted.
- provide better condition for tendon transfer.
- nerve repair is superior to spontaneous recovery .

LATE OBSTETRIC BRACHIAL PLEXUS PALSY:

The sequelae of late obstetric brachial plexus palsy depends on three factors whose effects are additive

- paralysis of muscle groups (external rotators and elbow flexors etc)
- contracture of healthy antagonist muscles of those that recuperate causing co-contractions
- impaired growth that leads to osseous deformities .

These are seen particularly after spontaneous recovery in grade 3 and grade 4 lesions.

COCONTRACTIONS:

There are mainly four types of cocontractions resulting from cross innervation causing different types of deformities of shoulder and elbow.

- cocontractions between shoulder abductors and adductors which result in limitation of shoulder elevation .
- cocontraction between elbow flexors (biceps and brachialis) and elbow extensors (triceps) which results in impairment of hand to back movement and hand to mouth movement. Flexion contracture of the elbow eventually results.

- cocontractions between elbow flexors and shoulder abductors results in Trumpet sign.

TRUMPET SIGN:



When the patient is asked to do hand to mouth movement, the shoulder will be involuntarily elevated as in a blowing a trumpet.

With this deformity, if the arm to body angle is less than 40° , then a mild cross innervation is present.

If the angle is more than 80° , severe cross innervation is present.

- cocontractions among shoulder abductors , elbow flexors and forearm flexors results in voluntary elbow and finger flexion when asked to do shoulder elevation .

Sequelae of obstetric brachial plexus palsy is classified as following types

Type I	Proximal limb type (53%)	Flaccid paralysis or partial paralysis of and elbow and occasionally forearm the shoulder.
Type II	Proximal and middle limb type (10%)	As type I with paralysis of triceps, pronator teres, flexor carpi radialis and finger extensors. latissimus dorsi is weak
Type III	Posterior cord type (10%)	Paralysis of shoulder abduction and elbow, wrist, finger and thumb extension.
Type IV	Whole limb / partial recovery (25%)	All muscles of the upper limb including hand are paralysed.

The shoulder sequelae in type I lesions are classified as following

Group 1	Late obstetric palsy with shoulder joint contracture (82%)
Subgroup 1 (63%)	Internal rotation and adduction contracture A – with joint sphericity and centralization preserved B – with joint deformity and posterior subluxation or dislocation
Subgroup 2 (14%)	External rotation and abduction contracture with anterior subluxation or dislocation A – with sphericity preserved B – with joint deformity
Subgroup 3 (34%)	Internal and external rotation contracture
Subgroup 4 (1.6%)	Pure abduction contracture
Subgroup 5	Very weak abduction
Group II	Pure flaccid paralysis

This classification is useful for selecting the most appropriate surgical procedure based on the particular pathologic condition of each case.

Observing the scapular sign is important when clinically evaluating the shoulder. The superomedial angle of the scapula elevates when passively rotating in the contrary direction of the contracted muscles when the arm is in adduction.

Thus if internal rotators are retracted, the scapular sign is positive while trying to externally rotate in adduction (putti's sign).

SUBGROUP 1A: INTERNAL ROTATION AND ADDUCTION CONTRACTURE WITH JOINT SPHERICITY AND CENTRALISATION PRESERVED:

The principle muscles with contracture are the subscapularis (upper fibres), pectoralis major and teres major mainly due to traction injury to the upper part of the brachial plexus and direct muscular trauma causing myostatic contracture of the anterior group of muscles of the shoulder.

By modified L'Episcopo procedure, it is possible to obtain good active external rotation and to preserve internal rotation.

By axillary approach, pectoralis major is always divided close to the humeral insertion followed by subscapularis.

Latissimus dorsi tendon is completely released and divided in a long Z forming two tendon strips .the distally inserted tendon strip is passed around the humerus and under the deltoid muscle emerging posteriorly in the quadrilateral space, the end of the distal tendon strip is fixed to the proximal tendon strip with the shoulder in 90 of abduction and maximal external rotation. Tension of suturing must allow complete adduction, else increased tension causes anterior dislocation of the shoulder and external rotation abduction contracture.

SUBGROUP 1B: INTERNAL ROTATION – ADDUCTION CONTRACTURE WITH JOINT DEFORMITY AND POSTERIOR SUBLUXATION OR DISLOCATION:

The deformity of the humeral epiphysis is produced by a primary epiphyseal displacement which increases during growth because of the initial lesion of epiphyseal cartilage and the persistent internal rotation contracture that compresses the humeral head against the glenoid leading to posterior subluxation or dislocation.

Clinically, there is more pronounced internal rotation contracture and muscle retraction with contracture of anterior deltoid.

Bony humeral epiphysis become laterally displaced, there is flattening of its medial aspect, producing a pear shaped appearance.

The glenoid fossa is hypoplastic and sclerotic leading to formation of a saddle joint in the shoulder. There is beaking and forward displacement of the acromion and downward prolongation of the coracoid.

Surgical correction is obtained by external rotation humeral osteotomy at the level of distal border of pectoralis major. This improves abduction of the shoulder by an average of 40° but does not change the pathologic congruence of glenohumeral joint .

SUBGROUP 2 : EXTERNAL ROTATION CONTRACTURE :

Clinically in this group active upper limb elevation is satisfactory but internal rotation is limited. During adduction and internal rotation, superior angle of scapula elevates under the trapezius. Typical scapular winging sign (Zancolli's sign) produced when hand of the patient is placed over the lumbar region.

External rotation contracture with anterior subcoracoid dislocations can be present in patients without previous treatment after prolonged use

of abduction external rotation splints or after surgical procedures that attempt to reduce a deformed joint in subgroup 1B.

Surgical correction is achieved by lengthening of the contracted posterior muscles of the shoulder like infraspinatus and teres minor in patients without deformity of the humeral head.

In patients with deformity of the humeral head, internal rotation osteotomy of the humerus can be done.

SUBGROUP 3: INTERNAL ROTATION AND EXTERNAL ROTATION CONTRACTURE:

In these patients, there is limitation of internal and external rotation as well as abduction and head is spherical. The subscapularis, teres minor and infraspinatus are retracted.

Both contractures can be corrected by releasing the affected muscles through separate incisions.

SUBGROUP 4 : PURE ABDUCTION CONTRACTURE :

It is very rare (1.6%) caused by isolated retraction of the supraspinatus muscle. Clinically there is marked elevation of scapula on passive adduction of the humerus.

Correction is achieved by Z lengthening of the supraspinatus tendon.

SUBGROUP 5 : VERY WEAK ABDUCTION :

In these patients active abduction is less than 30 and may present with external rotation or internal rotation contracture with external rotation paralysis. Usually deltoid and supraspinatus are paralysed.

Correction is achieved by dividing the latissimus dorsi and teres major close to its insertion. Teres major is transferred to the infraspinatus to act as external rotator. Latissimus dorsi tendon is sutured to the supraspinatus tendon and superior capsule in a more superficial layer.

GROUP II: PURE FLACCID PARALYSIS OF SHOULDER AND ELBOW:

There is no muscular contractures with paralysis of shoulder abduction and elbow flexion.

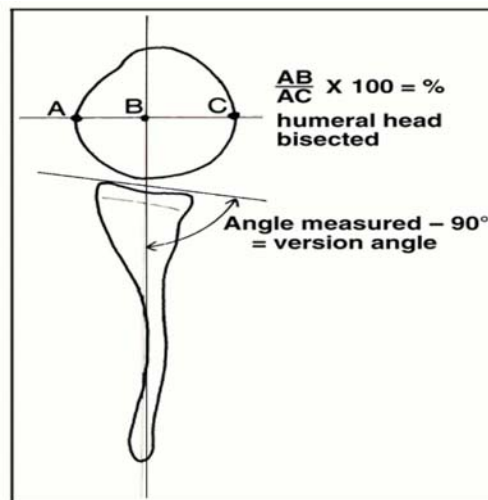
Elbow flexion should be reconstructed before shoulder abduction. Ideally a bipolar type of latissimus dorsi muscle transfer is preferred. In complete paralysis of the abductor muscles of the shoulder, an arthrodesis can be performed at the end of growth period.

In complete paralysis of the deltoid and supraspinatus with preserved function of other muscles, transfer of pectoralis minor and one posterior active muscle of the shoulder to supraspinatus tendon and then by a trapezius transfer to the humerus is done.

GLENOHUMERAL DEFORMITY SECONDARY TO OBSTETRIC BRACHIAL PLEXUS PALSY:

The glenohumeral deformity in obstetric brachial plexus palsy is analysed using X rays, CT and MRI.

Friedmann et al and Randelli and Gambrioli described the technique to measure the glenoid version (glenoscapular angle) and percentage of posterior subluxation of the humeral head .



To measure the glenoscaphular angle, a line is drawn parallel to the scapula and a second line is drawn tangential to the joint that connects the anterior and posterior margins of the glenoid. On MRI scans, the cartilagenous margins and in CT, the osseous margins are used.

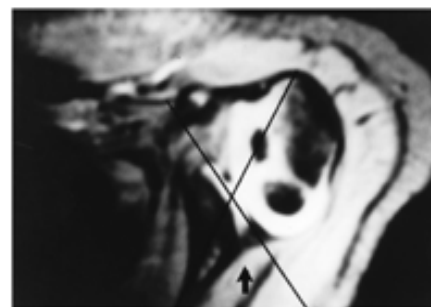
The angle formed in the posteriomedial quadrant by the two lines subtracted by 90 gives the glenoid version. Negative value indicates retroversion and a positive value indicates anteversion.

Percentage of posterior subluxation is measured by defining the percentage of the humeral head that is anterior to the scapular line.

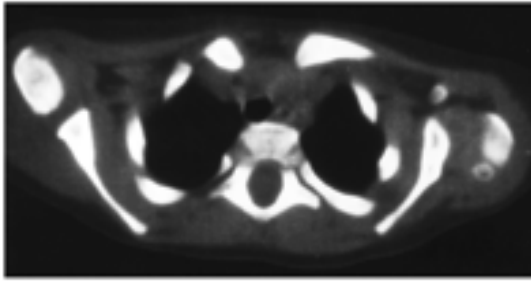
The greatest circumference of the head is measured as the distance from the scapular line to the anterior portion of the head. This ratio which is the distance to the anterior aspect of the humerus divided by the circumference of the humeral head multiplied by 100 is the percentage of subluxation.



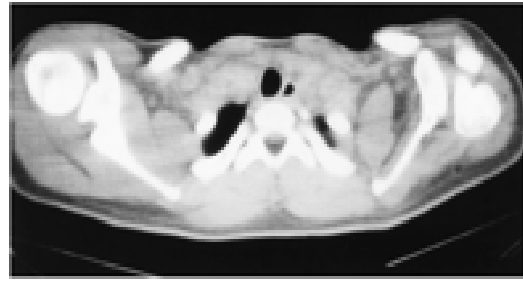
Type I



Type II



Type III



Type IV

Glenohumeral deformity and subluxation are graded radiographically as

Type I	Normal	<5 degree difference in retroversion compared to normal side.
Type II	Mild deformity	>5 degree difference in retroversion with no posterior subluxation of the head.
Type III	Moderate deformity	Posterior subluxation of the head with <35% of head anterior to the scapular line.
Type IV	Severe deformity	Formation of false glenoid.
Type V	Severe flattening of humeral head and glenoid with progressive or complete posterior dislocation of head.	
Type VI	Dislocation of glenohumeral joint in infancy.	
Type VII	Growth arrest of the proximal aspect of the humerus.	

When operative intervention has been contemplated, the choice between tendon transfer and humeral osteotomy is made based on the degree of osseous deformity of the glenoid.

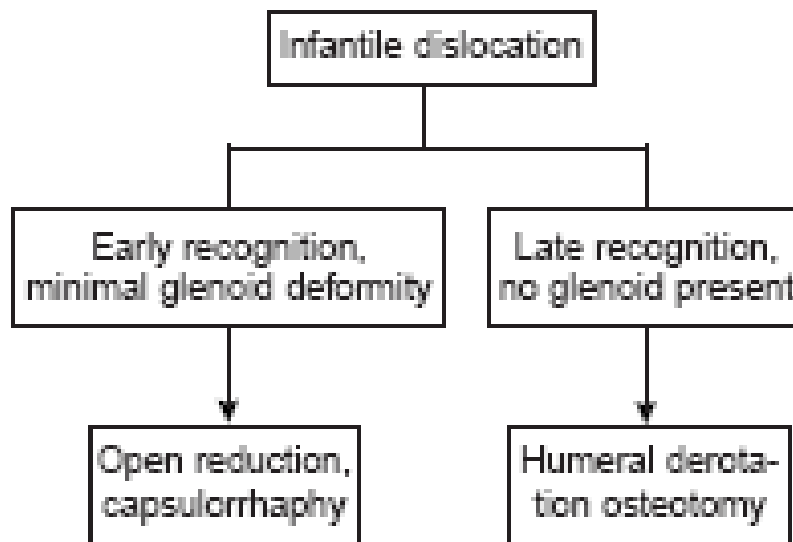
Patients who have type I and type II changes may be managed with a transfer and those who have type II changes may be managed with a humeral osteotomy. However intermediate types of deformity pose a more difficult problem because of the possibility of remodeling of the glenoid and humeral head. There is a striking association between increased age and severity of the glenoid changes. The age group in which this type of deformity was found correlated with the adolescent growth spurt of the glenoid and humeral head.

In younger patients who have minor deformity, the anterior release of the pectoralis major and transfer of the latissimus dorsi and teres major to the insertion of rotator cuff may correct the muscle imbalance early enough so that this may result in reconstruction of the glenohumeral joint.

By the time type V deformity is present, an osteotomy as a salvage procedure is the only option.

In rare instances, infants less than 1 year of age have a posterior dislocation of the glenohumeral joint. There is limitation of external

rotation, and the humeral head is palpably dislocated posteriorly. Ultrasonography, arthrography, CT, or MR imaging can be used to confirm the diagnosis.



FOREARM SEQUELAE OF LATE OBSTETRIC PALSY:

SUPINATION CONTRACTURE:

It occurs due to unrestricted effect of the supinator muscles (biceps and supinator) in the presence of pronation paralysis. Initially it can be reduced passively with time but interosseous membrane begins to contract becoming fixed, leading to curvature of the forearm bones leading to volar subluxation of distal end of ulna and volar subluxation or dislocation of radial head.

CLASSIFICATION AND MANAGEMENT OF SUPINATION

CONTRACTURE OF THE FOREARM :

TYPE	PATHOLOGY	MANAGEMENT
Type I	Supination contracture with good triceps function	-distal end of biceps tendon is rerouted in a pronated position -transfer of flexor carpi ulnaris to brachioradialis
Type II	Supination contracture with normal distal radioulnar joint With good triceps function With weak triceps function	-Interosseous membrane release Reroute the biceps tendon in a pronated position -interosseous membrane release Transfer of the flexor carpi ulnaris to brachioradialis deep to median nerve and the flexor tendons
Type III	Subluxation or dislocation of distal radioulnar joint	Interosseous membrane release with distal radioulnar fusion in neutral forearm rotation
Type IV	Palmar subluxation or dislocation of distal ulna and radial head	Interosseous membrane release Radial head excision and distal radioulnar joint fusion

SEQUELAE IN THE WRIST :

Obstetric brachial plexus palsy cause a flexible ulnar deviation of wrist due to muscle imbalance caused by paralysis of thumb extensors, extensor carpi radialis longus and brevis and flexor carpi radialis. Extensor carpi ulnaris is the only active wrist muscle.

In a child, simultaneously after correcting the supination contracture, extensor carpi ulnaris is passed through released interosseous membrane in a palmar direction rerouted around the palmar aspect of the radius deep to radial neurovascular bundle and sutured to extensor carpi radialis longus under tension in 20 degrees of wrist dorsiflexion.

If growth is completed, wrist arthrodesis can be done.

SEQUELAE IN THE HAND :

Radial paralysis	30%
Median and ulnar paralysis	8%
Diffuse paresis	13%
Total paralysis	21%
Irregular paralysis	28%

AIM

To analyse the functional results of muscle transfer for restoring abduction and external rotation in old obstetric brachial plexus palsy.

MATERIALS AND METHODS

This is a prospective study of 15 cases of old obstetric brachial plexus palsy with shoulder sequelae for whom latissimus dorsi and teres major muscle transfer was done for restoring abduction and external rotation.

The period of surgery and followup extends from November 2007 to November 2009.

In our series, nine were boys and six were girls. The age ranged from 3 to 14 years at time of surgery with an average of 6 years and 3 months.

Ten children were affected on the right side and five on the left side.

Thirteen cases were of the classical upper arm type and two cases were of whole arm type of brachial plexus palsy.

Of the fifteen cases seven cases gave history of difficult labour which varied from breech, instrumental delivery to vaccum extraction.

All the fifteen patients were followed up with a minimum followup period of 6 months to a maximum followup period of two and half years. The average followup period being two years.

All the fifteen patients who ranged from three to thirteen years had adduction and internal rotation contracture of the shoulder with excellent sensibility and motor function of the hand. Our patients had an average passive abduction of 15 to 100 degrees with a deltoid power of grade 3 or 4 and average passive external rotation 10 to 15 degrees with a latissimus dorsi and teres major power of grade 3 or 4.

Two patients with global palsy who had undergone microneural reconstruction had shoulder sequelae for whom latissimus dorsi and teres major muscle transfer was done after regaining partial neurological recovery and good hand function.

For the first 3-4 years after the onset of palsy, children were treated with passive and active exercises, and with dynamic orthosis that substituted for weak muscles and encouraged use of the limb.

Serial muscle examinations showed additional muscle function developed throughout this period. If at this time there was good sensibility and muscle function of the hand, reconstructive surgery of the shoulder is considered.

All the fifteen patients were grouped into three categories based on their shoulder problems as follows.

GROUP	SHOULDER SEQUELAE	NUMBER OF CASES
Group 1	Absent external rotation with internal rotation contracture	8
Group 2	Internal rotation contracture with joint deformities	5
Group 3	Absent or weak active external rotation with good passive external rotation	2

Group 1 patients with absent external rotation with internal rotation contracture with a normal glenohumeral joint were treated with anterior soft tissue release which includes release of subscapularis, pectoralis major, latissimus dorsi and teres major and transfer of latissimus dorsi to supraspinatus and teres major to infraspinatus for restoring abduction and external rotation.

Group 2 patients had internal rotation contracture with joint deformities at the shoulder joints. All the five were older patients and were treated with anterior soft tissue release derotational osteotomy of the humerus just below the level of insertion of pectoralis major along with a

transfer of latissimus dorsi and teres major to supraspinatus and infraspinatus respectively.
















Group 3 patients with absent or weak active external rotation with good passive external rotation were treated with latissimus dorsi and teres major muscle transfer to rotator cuff only.

All the patients were assessed for the functional outcome with preoperative and post operative Mallet scoring, active abduction and external rotation.

A modification of Mallet scoring system can be used to define the recovery of the upper-trunk function in infants. It has five separate categories for global abduction, global external rotation, and hand-to-mouth, hand-to-neck and hand-to-sacrum function. Grading is on a scale from 0 to 5, with 5 being normal and 0 being no muscle contraction grades 2 to 4 are in between them.

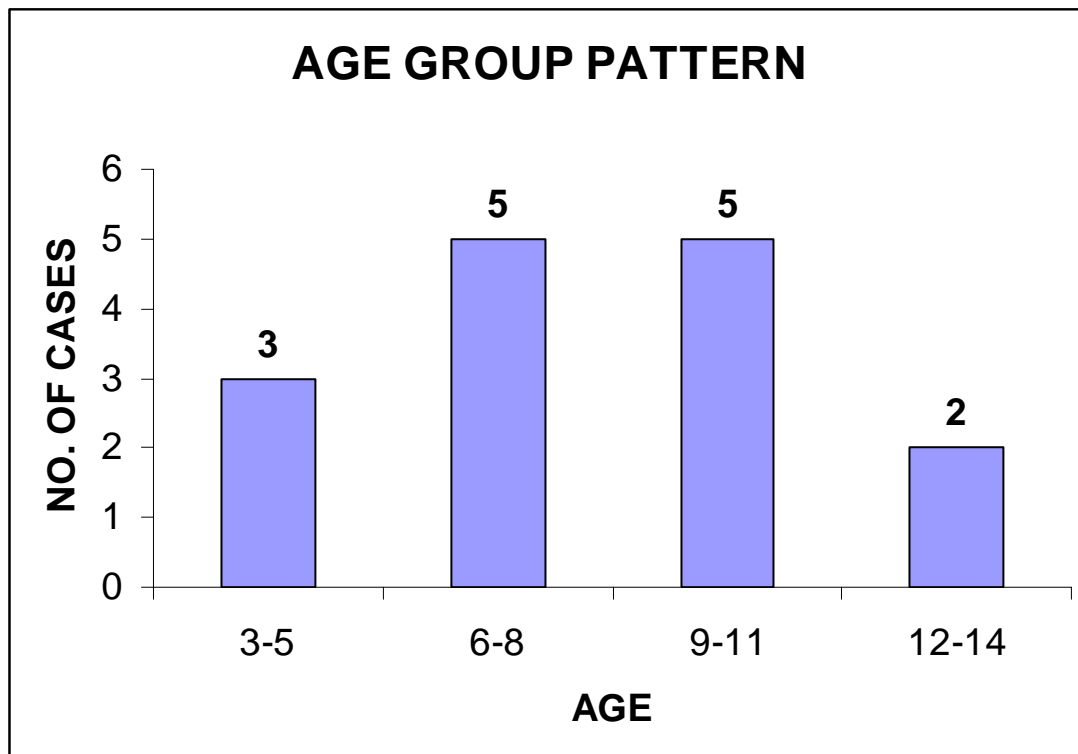
It was done for all children. Grade I indicates a stiff shoulder or a flail arm. Grade V indicate a clinically normal Shoulder. The in-between grades are elaborated in table below:

	CLASS I	CLASS II	CLASS III	CLASS IV
Global abduction	None	< 30 degrees	30 -90 degrees	>90 degrees
External rotation	None	<0 degrees	0-20 degrees	>20 degrees
Hand to neck ability	None	Not possible	Difficult	Easy
Hand to mouth ability	None	Marked trumpet	Partial trumpet	< 40 degrees abduction
Internal rotation	None	To S1	To S1	To T12

	Grade II	Grade III	Grade IV
Global abduction	 <30°	 30° to 90°	 >90°
Global external rotation	 <0°	 0° to 20°	 >20°
Hand to neck	 Not possible	 Difficult	 Easy
Hand on spine	 Not possible	 S1	 T12
Hand to mouth	 Marked trumpet sign	 Partial trumpet sign	 <40° of abduction

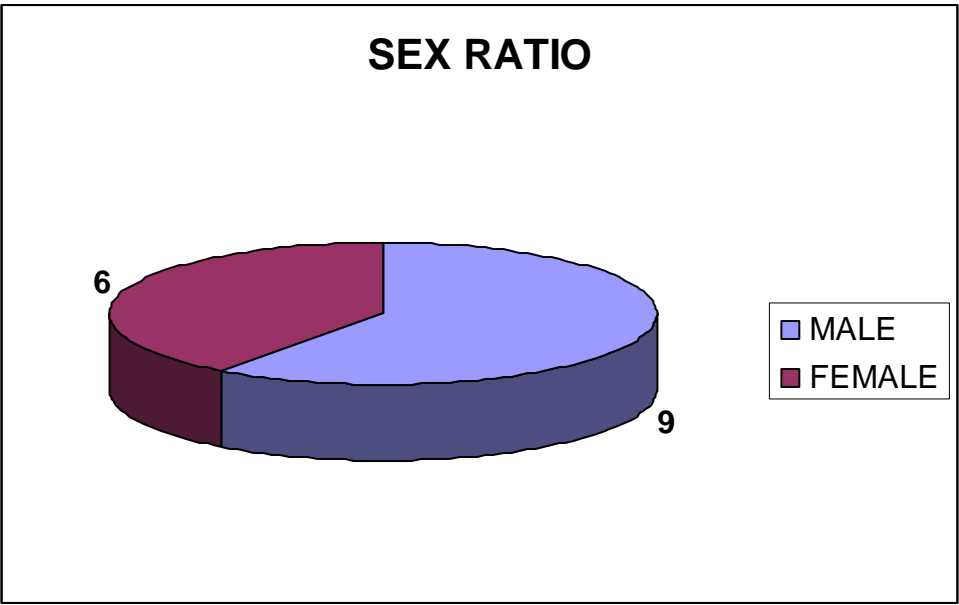
AGE GROUP PATTERN

AGE GROUP	NO. OF CASES
3-5	3
6-8	5
9-11	5
12-14	2
TOTAL	15



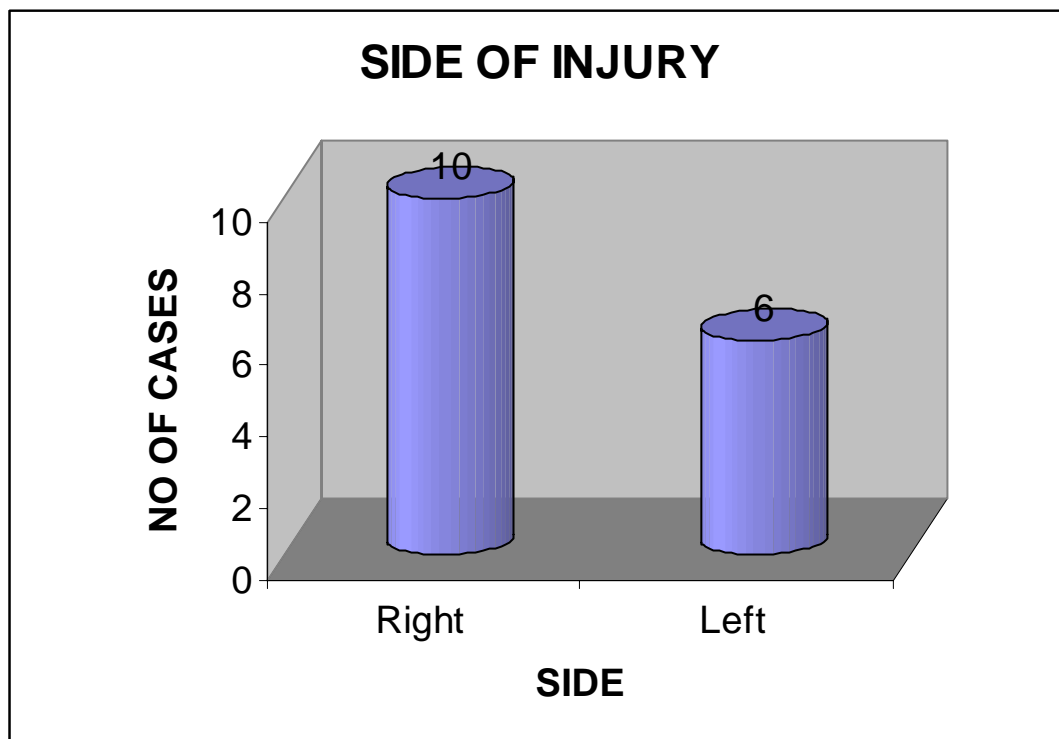
SEX RATIO

SEX	NO. OF CASES
MALE	9
FEMALE	6



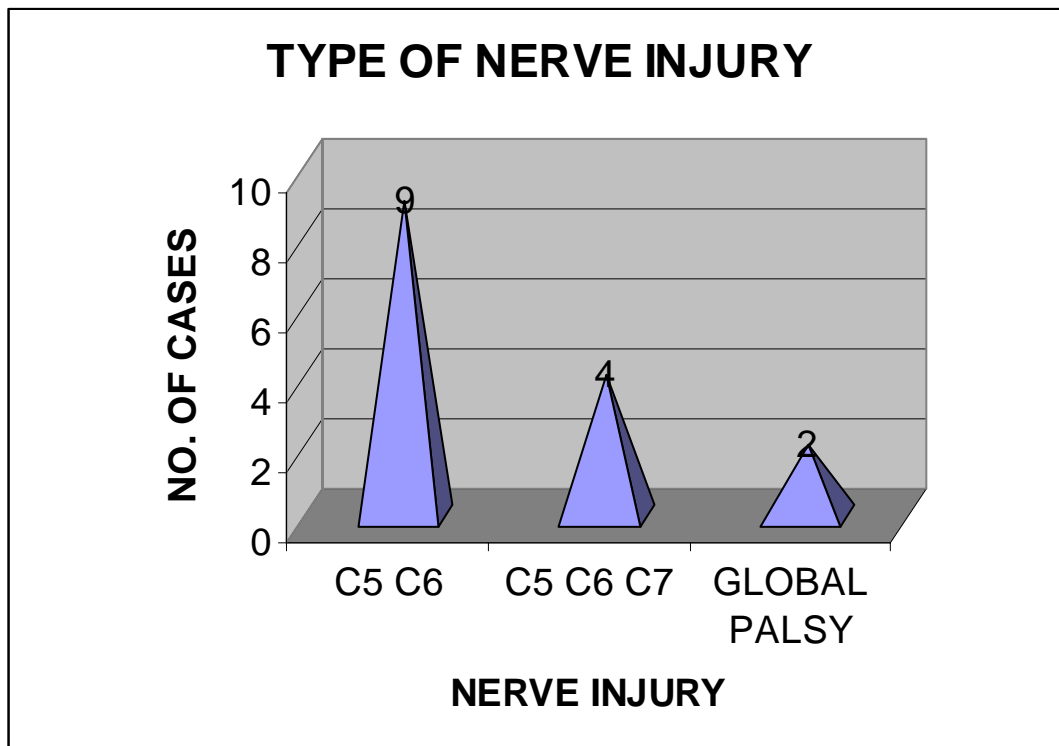
SIDE OF INJURY

SIDE OF INJURY	NO. OF CASES
Right	10
Left	6



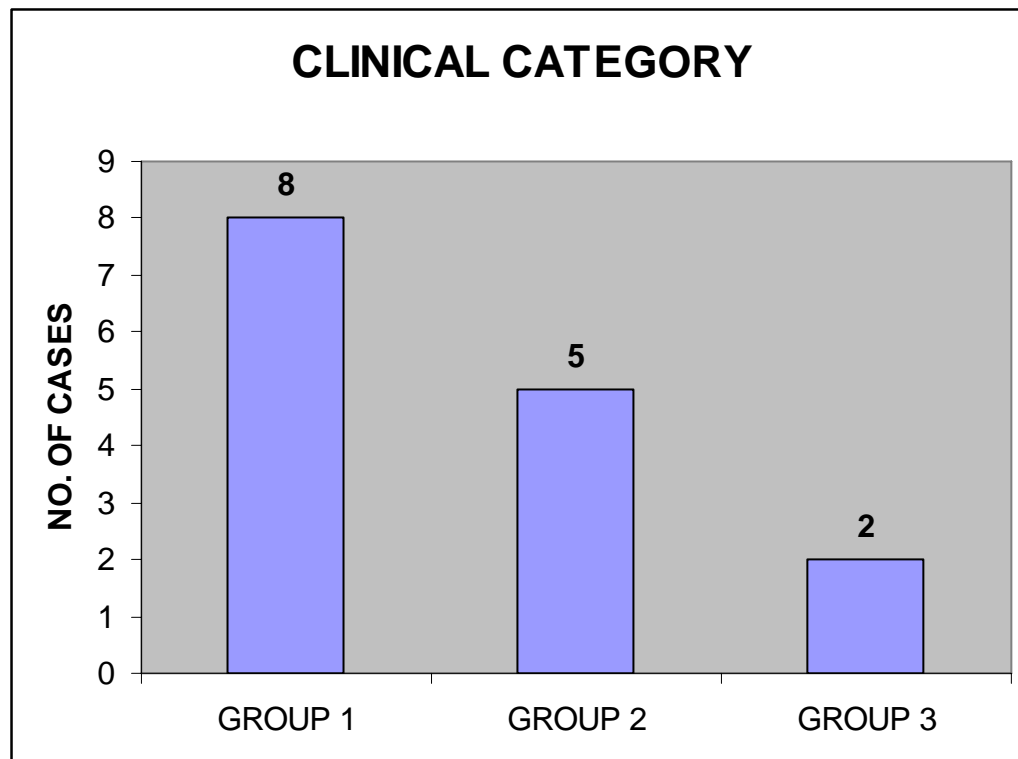
TYPE OF NERVE INJURY

NERVE INJURY	NO. OF CASES
C5 C6	9
C5 C6 C7	4
GLOBAL PALSY	2



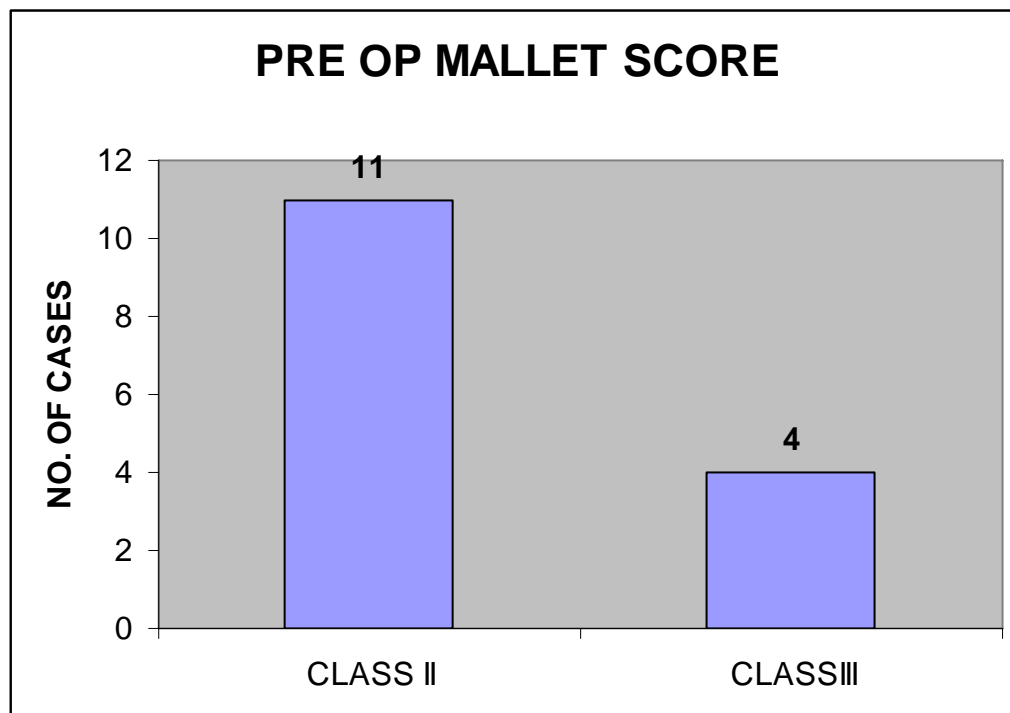
CLINICAL CATEGORY

CLINICAL CATEGORY	NO. OF CASES
GROUP 1	8
GROUP 2	5
GROUP 3	2



PRE OP MALLET SCORE

PRE OP MALLET SCORE	NO. OF CASES
CLASS II	11
CLASSIII	4



OPERATIVE TECHNIQUE:

ANAESTHESIA AND POSITIONING:

With patient under general anaesthesia, in lateral position, the paralysed extremity is draped free, so that both anterior and posterior aspects of the shoulders are exposed.



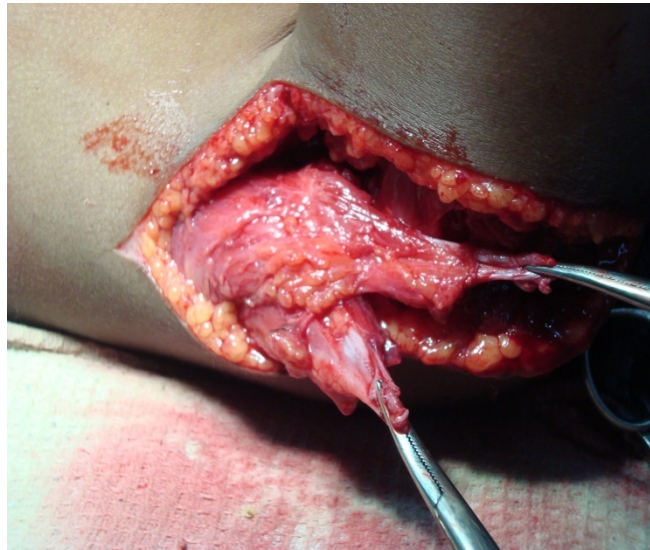
PROCEDURE



A 3 cm short anterior axillary incision is made along the anterior axillary border and the tight subscapularis, pectoralis major are released. The conjoint tendon of latissimus dorsi and teres major are released from the bicipital groove allowing increased abduction and external rotation.

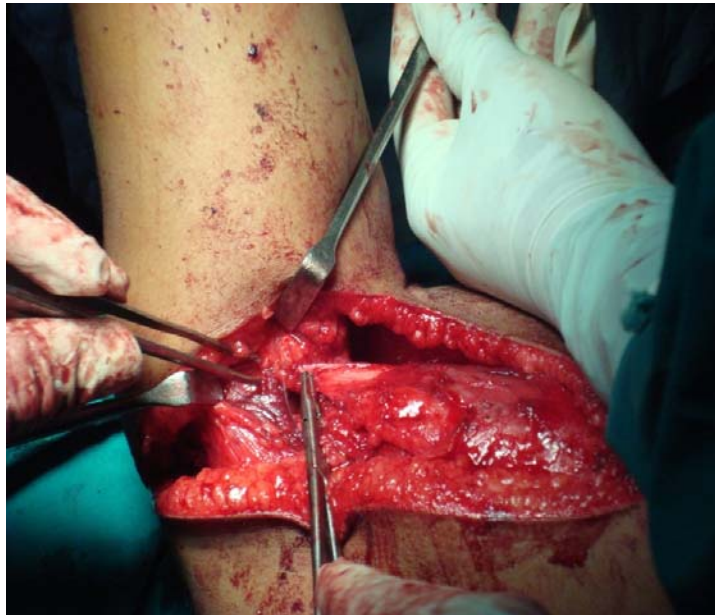


Through a second posterior axillary incision extending on to the posterior aspect of the shoulder, the insertion of latissimus dorsi and teres major were identified as a conjoint tendon and were retrieved posteriorly.



During this part of the procedure, care is taken not to injure the radial nerve and the contents of the quadrilateral space.

The interval between the posteroinferior margin of the deltoid and rotator cuff is then developed and the arm is maximally abducted and externally rotated. The released latissimus dorsi and teres major tendons then were transferred posterior to the long head of triceps and latissimus dorsi is sutured to supraspinatus and teres major is sutured to infraspinatus.



By this maneuver the latissimus dorsi is converted as an abductor and teres major is converted as an external rotators of the shoulder.

Wound is closed with subcuticular sutures for cosmesis.

POSTOPERATIVE PROTOCOL

Postoperatively, the upper limb is immobilized in a prefabricated abduction splint with shoulder in 90° abduction, 45° external rotation, 30° of forward flexion and elbow in 90° flexion and full supination which allows regular dressing of the wound. SR done on the 12th post operative day.



The limb is put on the splint for a period of 4 wks. thereafter the arm is gradually brought down to the side .

Intermittent splinting was followed for upto 6 weeks. For atleast 8 weeks postoperatively, the patient is put on abduction splint at night.

Shoulder is put on active and assisted exercise. It is ensured that the parents are strictly carrying out the exercises regime. Patient is reviewed once in two week for the first 3 months. After 3 months, child is seen every month upto 1 year followed by once every year.

RESULTS AND ANALYSIS

In our series of cases the average post operative abduction was 114.75 degrees, as against pre-operative value of 65.25 degrees for the upper arm type of palsy. We compared the results of upper and the whole arm types separately as the overall functional outcome varied widely because of the wrist and hand involvement in the whole arm types. The average abduction was improved from 15 degrees to 65 degrees in children with the whole arm type of palsy.

Type of palsy	Pre-op Abd.	Post-op Abd.	Pre-op Ext. rot.	Post-op Ext. rot.	Mallet score
Upper arm	65.25	114.75	-7.75	22.25	4
Whole arm	15	65	-15.625	11.25	3

The average internal rotation contracture in children with upper arm type was -7.75 degrees which improved to 22.5 degrees after the surgery.

However in the children with whole arm type of palsy the average post operative rotation was 11.25 degrees against pre-operative average internal rotation deformity of -15.625 degrees.

One patient of Mallet class III had rupture at the suture site. One patient of Mallet class II had absent internal rotation of his left hand. There was no evidence of infection in any of our cases.

All the children in our series were evaluated by modified Mallet scoring system. There was significant improvement of abduction and external rotation in all our patients revealed by improvement in Mallet scores in almost all the patients.

PRE OP MALLET SCORE	POST OP MALLET SCORE	NO OF PATIENTS
2	5	6
2	4	3
2	3	1
3	5	3
3	4	1

Mallet in his original study describes, a score of 3 is enough to perform day to day activities satisfactorily. In our study group, 14 out of the 15 children affected with upper arm type of involvement achieved a Mallet score of above 3 in their latest follow ups. One child of global palsy had a Mallet score of 3. The poor scores of the whole arm group is

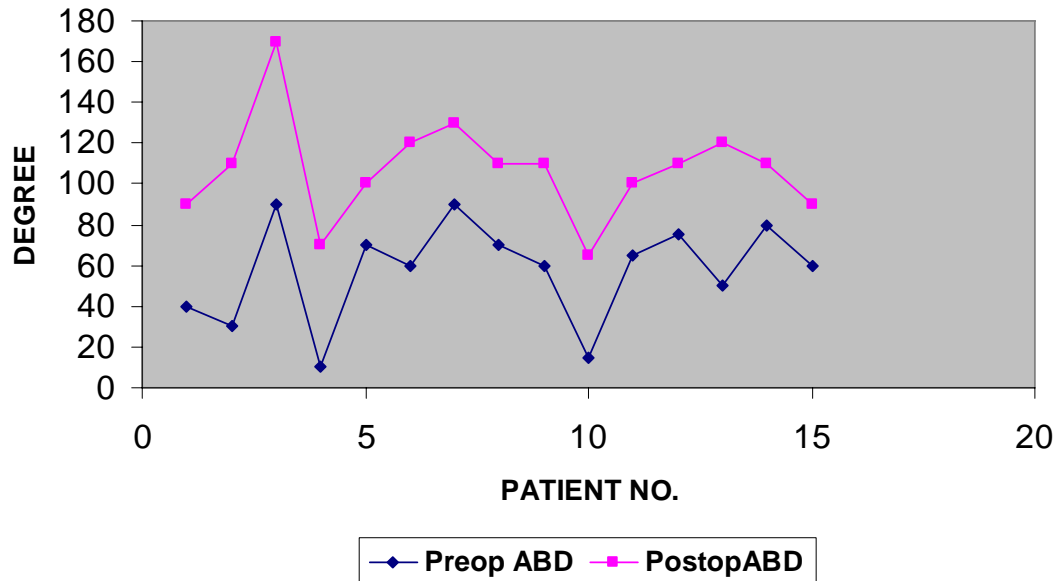
attributed to the involvement of the distal upper extremity. It was the encouraging scores in the upper arm group which prompted us to carry on with this surgical procedure for residual deformity in Obstetric Brachial plexus (Erb's) palsy.

All cases of upper arm type of obstetric brachial plexus palsy showed significant improvement in abduction and external rotation characterized by higher Mallet scores (class IV and class V) in all the cases.

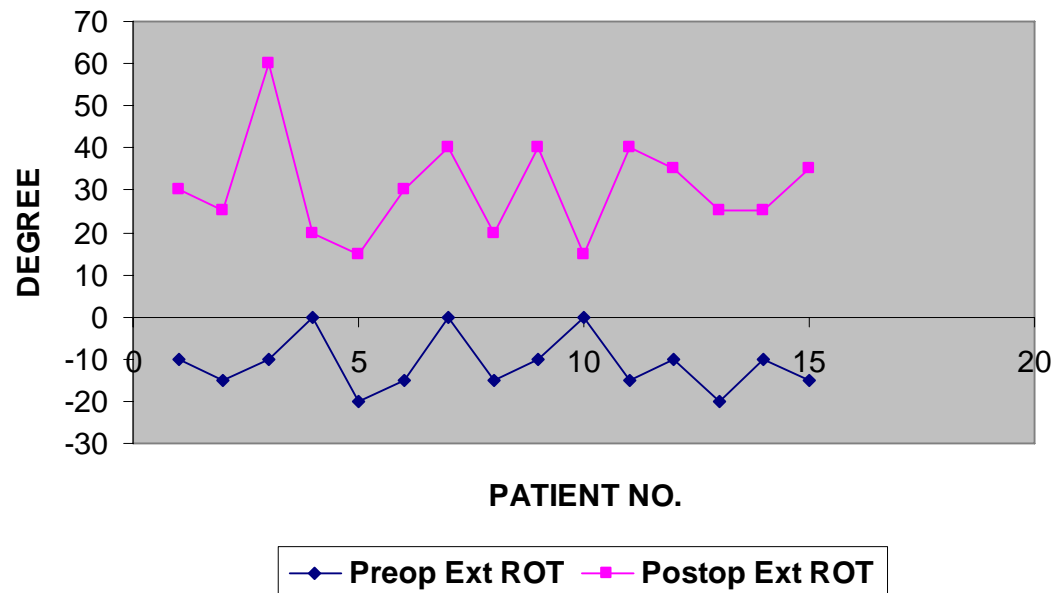
It was also observed that there was no difference in age at the time of surgery to the ultimate functional results.

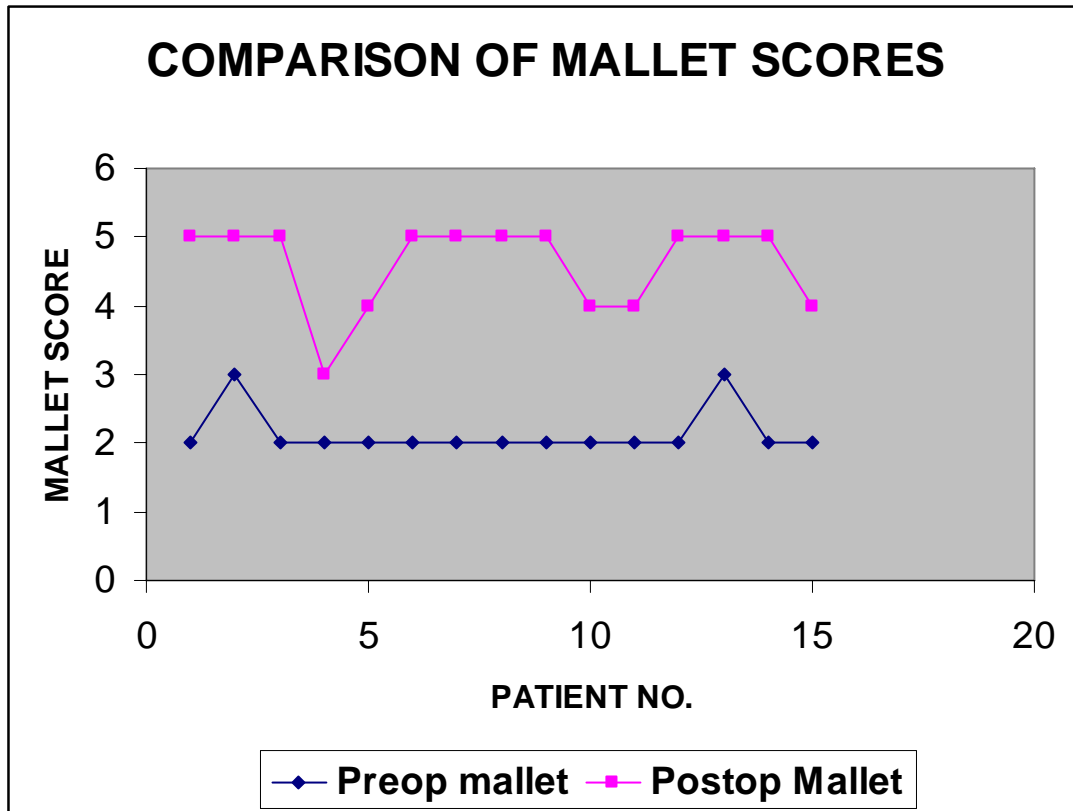
Also it was noted that patients with moderate range of abduction and external rotation preoperatively had significant improvement in abduction and external rotation post operatively. There was no deterioration in range of motion in any of our patients.

COMPARISON OF ABDUCTION RANGE



COMPARISON OF EXTERNAL ROTATION RANGE





DISCUSSION

The common disability after obstetric brachial plexus palsy is limitation of external rotation and abduction of the shoulder which impairs the patient from carrying out their day to day basic activities particularly eating if their right upper limb is affected.

Lattismus dorsi and teres major muscle transfer to the rotator cuff helps in restoring abduction and external rotation in a case of late obstetric brachial plexus palsy.

The results were very satisfactory not only in the functional aspect but also had a huge impact in residual deformity of the limb.

Knowledge of muscle imbalance, cross innervation and cocontractions help in early recognition of contracures around the glenohumeral joint.

Early and timely surgical release and muscle transfer not only improves the biomechanics and function of the glenohumeral joint but also prevents glenohumeral deformities.

Glenohumeral deformities like flattening of the glenoid, elongated coracoid posterior subluxation and dislocation of the shoulder when developed requires extensive surgical release on the anterior aspect with a

derotational osteotomy. The derotational osteotomy does not correct the glenohumeral deformity per se. Along with lattismus dorsi and teres major muscle transfer, it helps in significant improvement in abduction and external rotation.

In our series in five patients who had glenohumeral deformities, derotational osteotomy with anterior release of subscapularis and pectoralis major along with lattismus dorsi and teres major muscle transfer to the rotator cuff was done. All 5 patients showed significant improvement in abduction and external rotation and post op mallet scores.

So selection of correct surgical technique at an appropriate time is required to correct shoulder sequelae in late obstetric brachial plexus palsy patients.

One striking thing noted in the literature is that several authors have adopted some slight modifications in the procedure to achieve variable results.

Sever et al. provided a review of the pathology and clinical aspects of 40 cases. He was the one to determine the traction theory of injury which was accepted by most observers.

Sever even remarked that when the head and shoulder are separated, the upper cords (C5 and C6) stand out like ‘violin strings’. He outlined the surgical procedure which was designed not to open the joint which was contrary to Fairbank. He used an anterior exposure to release the anterior contracted structures such as pectoralis major and subscapularis.

Though the internal rotation contracture was released, patient did not achieve an active external rotation and abduction.

L’Episcopo published two important articles in the same subject. He analysed Sever’s results and attributed the recurrence rates of the internal rotation contracture to the muscle imbalance following anterior release. He strongly believed that the deformity in the brachial plexus palsy is the result of imbalance between the internal and external rotators of the shoulder. For this he advised to transplant the insertion of teres major to the posterolateral aspect of the humerus. He made clear that the latissimus dorsi and teres major tendons were often conjoined and are transferred together, changing the action of these muscles from internal to external rotation.

Strecker et al. in his series has sutured the tendons of latissimus dorsi and teres major to the posterior fibres of deltoid hoping to improve the abduction as well as external rotation.

Kirkos et al. forwarded Merle d' A ubigne technique where he sutured the tendons to the humeral stump of the divided tendon of pectoralis major.

Hoffer et al. in his series sutured the divided tendons of latissimus dorsi and teres major to the rotator cuff.

As there are only minor differences between the various modifications and all addresses the muscle imbalance between the internal and external rotators of shoulders, we can compare the long term results of the surgical technique with our series.

Kirkos et al. in their series of similar transfers achieved a mean postoperative abduction of 77 degrees and external rotation of 10.5 degrees. The mean external rotation in the Strecker et al. series was 78 degrees and in that of Covey et al. series was 29 degrees.

Hoffer et al. in his series of 11 cases, had an average gain of active abduction and external rotation of 45 degrees.

The above results are comparable to our series where we achieved mean shoulder abduction of 114 degrees and external rotation of 25 degrees providing functional improvement to the patients.

Thus the transfer of teres major and latissimus dorsi to the rotator cuff is a modification of previously devised procedures. It has the advantage of being easily performed and it increases active external rotation and abduction. It enhances the stabilizing effect of rotator cuff and increases glenohumeral abduction because it enables the deltoid to be more effective.

CONCLUSION

The surgeon has to be aware of muscle imbalance and internal rotation contracture in all cases of old obstetric brachial plexuses palsy.

Early and timely surgical release and muscle transfer even as early as 2 years prevents glenohumeral deformities and improves the function of shoulder joint.

Correct choice of surgical procedure will improve the function and outlook in these patients.

Latissimus dorsi and teres major muscle transfer restores abduction and external rotation in most of the patients with late obstetric brachial plexus palsy. Apart from functional improvement this procedure corrects a deformity thereby easing the psycho-social stigma associated with it, especially in our part of the country.

Muscle transfer definitely deserves role in the armamentarium of the reconstructive surgeon treating patients with shoulder deformity and weakness after obstetric brachial plexus palsy.

BIBLIOGRAPHY

1. Hoffer MM, Wickenden R, Roper B : **BRACHIAL PLEXUS BIRTH PALSIES : RESULTS OF TENDON TRANSFER TO THE ROTATOR CUFF** . *J bone joint surgery* 1978, 60A:691-695
2. Birch R (2003) late sequelae at the shoulder in obstetric palsy in children. In: Duprac J (eds) shoulder. Elsevier , paris , pp 55-200-E-210.
3. Friedman RJ ,Hawthorne KB, Genez BM (1992) The use of computerized tomography in the measurement of glenoid version . *J Bone Joint Surg Am* 74(7):1032-1037
4. Waters PM ,Bae DS (2005) Effect of tendon transfer and extra-articular soft-tissue balancing on glenohumeral development in brachial plexus birth palsy . *J Bone Joint Surg Am* 87(2):320-325. DOI 10.2106/JBJS.C.01614.
5. Waters PM, Bae DS (2006) The effect of derotational humeral osteotomy on globular shoulder function in brachial plexus birth palsy . *J Bone Joint Surg Am* 88(5):1035-1042. DOI 10.2106/JBJS.E.OO680.
6. Waters PM, Smith GR, Jaramillo D (1998) Glenohumeral deformity secondary to brachial plexus birth palsy . *J Bone Joint Surg Am* 80(5):668-677.

7. Nath RK, Paizi M: Scapular deformity in obstetric brachial plexus palsy: a new finding .Surg Radiol Anat 2007, 29:133-140.
8. Narakas AO : Obstetric brachial plexus injuries. In The Paralyzed Hand.Edited by: Lamb D,Edinburgh :Churchill Livingstone; 1987: 116-135.
9. Terzis JK, Vekris MD, Okajima S, Soucacos PN : Shoulder deformities in obstetric brachial plexus paralysis: a computed tomography study. J Pediatr Orthop 2003, 23:254-260.
- 10.Mallet J: Obstetric paralysis of the brachial plexus. II. Therapeutics. Treatment of sequelae. Priority for the treatment of the shoulder. Method for the expression of results. Rev Chir Orthop Reparatrice Appar Mot 1972, 58 Suppl 1:166-168.
- 11.Hoeksma AF, Ter Steeg AM, Dijkstra P, Nelissen RG, Beelen A, de Jong BA: Shoulder contracture and osseous deformity in obstetrical brachial plexus injuries. J Bone Joint Surg Am 2003, 85-A:316-322.
- 12.Valerie M, Ed O Van Kooten:An MRI study on the relations between muscle atrophy, shoulder function and glenohumeral deformity in shoulders of children with obstetric brachial plexus injury:Journal of Brachial Plexus and Peripheral Nerve Injury 2009,4:5 DOI:10.1186/1749-7221-4-5

13. Babbitt, D.P., and Cassidy, R.H.; Obstetric paralysis and dislocation of the shoulder in infancy .J Bone and Joint Surg ,50-A: 1447-1452, Oct. 1968.
14. Zancolli EA, Zancolli ER Jr. Palliative surgical procedures in sequelae of obstetrical palsy In: Tubina R, ed. The hand vol 4, Philadelphia: Saunders, 1993:602-23.
15. Gilbert A, Tassin J. Reparation chirurgicale du plexus brachial dans la paralysie obstetricale. Chirurgie 1984;100:70-5
16. Slooff A. Obstetric brachial plexus lesions and their neurological treatment . Clin Neurol Neurosurg 1993;95:73-7.
17. L'Episcopo, J.B.:Tendon Transplantation in obstetrical paralysis. Am. J. Surg.,25:122-125,1934.
18. Fairbank, H.A.T.:Birth palsy: subluxation of the shoulder-joint in infants and young children. Lancet. 1: 1217-1223,1913.
19. Zachary, R.B.:Transplantation of teres major and latissimus dorsi for loss of external rotation at the shoulder. Lancet,2:757-758,1947.
20. Liebolt, F.L., and Furey, J.G.:Obstetrical paralysis with dislocation of the shoulder. A case report .J. Bone and Joint Surgery.,35-A:227-230, Jan 1953.

PROFORMA

1. Study patient Serial No.
2. Name
3. Age
4. Sex
5. Hospital IP No
6. Mailing address
7. Date of Admission
8. Date of surgery
9. Date of discharge
10. History of breech presentation at birth
11. Dexterity
12. Details of physiotherapy, if any
13. Type of paralysis i.e. upper or whole arm
14. Follow-up period
15. Pre operative deformity, shoulder abduction & external rotation
16. Post operative abduction, external rotation
17. Post operative Mallet score
18. Complications(intra- op, post- op & late)

MASTER CHART

Patient No	Age	Sex	Dextrity	Type	Preop ABD	Preop Ext ROT	Preop mallet	PostopABD	Postop Ext ROT	Postop Mallet
1	5	M	R	U	40	-10	II	90	30	V
2	7	F	R	U	30	-15	III	110	25	v
3	7	M	R	U	90	-10	II	170	60	V
4	9	F	L	W	10	0	II	70	20	III
5	14	M	R	U	70	-20	II	100	15	IV
6	4	F	L	U	60	-15	II	120	30	V
7	9	M	R	U	90	0	II	130	40	V
8	6	M	R	U	70	-15	II	110	20	V
9	10	M	L	U	60	-10	II	110	40	V
10	11	M	R	W	15	0	II	65	15	IV
11	3	F	L	U	65	-15	II	100	40	IV
12	10	F	L	U	75	-10	II	110	35	V
13	8	M	R	U	50	-20	III	120	25	V
14	12	F	R	U	80	-10	II	110	25	V
15	10	M	R	U	60	-15	II	90	35	IV

CASE 1: MANIKANDAN 5YRS/ MALE

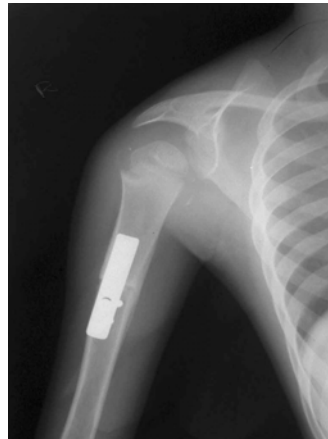
PRE OP RANGE OF SHOULDER MOTION :



POST OP SHOULDER RANGE OF MOTION:



CASE 2 RAJENDRAN 7 Yrs MALE



Mallet class II -Soft tissue release +muscle transfer+derotational osteotomy



CASE 3 – RAVI – 9 Yrs MALE

PRE OP ABDUCTION



PRE OP ABDUCTION



TRUMPET SIGN



CHECK XRAY



POST OF ABDUCTION AND INTERNAL ROTATION